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DESIGN AND DEVELOPMENT OF A PNEUMATIC GIMBAL ACTUATION SYSTEM

Monthly Technical Report

May 1966 9

Contract NAS8-5407

Submitted to

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Alabama 35812

N67-83388

by

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Monthly Technical Report for May 1966

This report covers activities at the Bendix Research Laboratories Division under Contract NAS8-5407, Modification No. 9, during the period of 1-31 May 1966. It is anticipated that a contract modification will be required to increase the period of performance of the development effort. A request for contract change is being prepared to increase the period of performance from "thirty-six (36) consecutive months" to "thirty-nine (39) consecutive months". This contract modification will be requested with no change in estimated cost or fixed fee. This extension is necessary to accommodate unanticipated problems occurring during the course of the contract effort. These problems included rework of the actuator prior to systems test, due to damaged balls in the ball spline, and failure of the flange on the ball nut of the actuator during initial open loop tests.

Although every effort was made to offset the delays experienced, it is necessary to request an extension to successfully complete the subject contract.

1. TECHNICAL PROGRESS

1.1 Phase I: Gear Motor Development

Development tests of the motor at -250°F were initiated after assembling with the bearings and seals required for cryogenic operation. During these tests the gear motor has experienced no difficulties, and the data which has been taken correlates with the predicted operation at -250°F using hydrogen. However, operation of the motor control valve has been intermittent, experiencing a sticking spool. Additional testing of the valve is being conducted to isolate the problem area.

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The performance of the heat exchanger was excellent in that it provided -250°F hydrogen at maximum flow conditions while operating with only half of the coils in use.

1.2 Phase II: Epicyclic Motor Development

Fabrication of the DYNAVECTOR motor was completed and assembly started. The assembly procedure includes the following steps:

1. Align end caps and install dowel pins.
2. Lap mating gears.
3. Assemble and run motor with fine lapping compound to complete gear finishing.
4. Green run motor for several hours to remove rough spots and wear in sliding surfaces.

This assembly procedure will be completed in June, and the motor will be ready for performance testing.

A test plan has been prepared and is being published. Quantities to be measured include:

1. Stall Torque Characteristics
2. Stall Torque Efficiency
3. Torque-Speed Characteristics
4. Flow Characteristics
5. Frequency Response
6. Speed Characteristics

Other items to be evaluated include:

1. Wear Areas
2. Balance Effectiveness
3. Weak Design Points
4. Improvements

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Further analysis on commutation problems has uncovered a weak point in the design fabricated. Insufficient commutation area exists. In order to verify this study, a set of modified end caps and commutation plates doubling the commutation area are being fabricated. At the completion of preliminary testing, these modified items will be assembled and evaluated.

1.3 Phase III: Development of a Photoviscous Technique for Fluid Flow Studies

The test stand has been completely checked out and readied for delivery. Drafts of both Volume I, Theory and Experiments and Volume II, Operating Instructions for the Photoviscous Test Stand, have been completed and released for final typing and artwork.

An inventory of all material purchased under this Phase has been completed, and all items were accounted for.

All technical work under this Phase of the contract has been completed.

2. PLANS FOR NEXT PERIOD

Valve tests will be conducted to identify the course of intermittent operation at -250°F . The actuator will be reassembled using the bull gear from the second actuator and room temperature system tests initiated.

Assembly of the DYNAVECTOR motor will be completed and development tests initiated.

The photoviscous test stand will be delivered, and the final report for the photoviscous phase will be published.

MILESTONE - CUMULATIVE COST REPORT

"Design and Development of a Pneumatic Gimbal Actuator"

CONTRACT NAS 8-5407
GEORGE C. MARSHALL SPACE FLIGHT CENTER (NASA)

MAJOR MILESTONES		1965												1966		1967	
NO.	DESCRIPTION	JUN	JUL	AUG.	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	CUMULATIVE COST - THOUSANDS OF DOLLARS (INCLUDES COMMITMENTS - DOES NOT INCLUDE FEE)	ACTUAL ACHIEVEMENT DATE	FORECASTED ACHIEVEMENT DATE
PHASE I PNEUMATIC GEAR MOTOR DEVELOPMENT																	
1.1	COMPLETE DESIGN AND RELEASE FOR FABRICATION AND PROCUREMENT				▲			▽							150	9-17-65	9-17-65
1.2	COMPLETE ASSEMBLY									▲					140	2-1-66	2-1-66
1.3	COMPLETE PERFORMANCE EVALUATION										▽				130	2-28-66	2-28-66
1.4	COMPLETE REWORK FOR SUBSYSTEMS TESTS											▽			120	3-18-66	3-18-66
1.5	COMPLETE CHECKOUT OF N.V. B-1 ACTUATOR AND ENGINE SIMULATION FIXTURE														110	3-18-66	3-18-66
1.6	COMPLETE PERFORMANCE EVALUATION OF N.V. B-1 ACTUATOR WITH GEAR MOTOR														100	6-3-66	6-3-66
PHASE II EPICYCLIC SERVO MOTOR FEASIBILITY DEMONSTRATION																	
2.1	COMPLETE PRELIMINARY BREADBOARD MODEL REQUIREMENTS														90	8-20-65	8-20-65
2.2	COMPLETE DESIGN ANALYSIS														80	9-17-65	9-17-65
2.3	COMPLETE COMMUTATION DESIGN STUDY														70	10-15-65	10-15-65
2.4	RELEASE DESIGN FOR FABRICATION														60	2-1-66	2-1-66
2.5	RECEIVE SERVOVALVE AND AMPLIFIER FROM M3FC														50	2-4-66	2-4-66
2.6	COMPLETE ASSEMBLY OF BREADBOARD MOTOR														40	4-3-66	4-3-66
2.7	COMPLETE DEVELOPMENT TESTS														30	6-3-66	6-3-66
PHASE III PHOTOVISCOUS FLUID FLOW STUDY																	
3.1	COMPLETE LITERATURE SURVEY AND GENERAL ANALYSIS														20	9-3-65	9-3-65
3.2	COMPLETE SPECIFICATION AND LAYOUT DESIGN OF APPARATUS														10	9-3-65	9-3-65
3.3	SELECT COMPONENT MODEL FOR STUDY														0	11-19-65	11-19-65
3.4	COMPLETE FABRICATION AND CHECKOUT OF APPARATUS														0	5-1-66	5-1-66
3.5	COMPLETE EXPERIMENTATION AND DATA REDUCTION														0	5-20-66	5-20-66
REPORTING																	
SUBMIT FINAL REPORT																	
		3,000	16,450	29,900	43,900	57,000	72,200	88,500	104,500	119,400	132,402	141,302	150,902	157,902		FORECAST COST (EXCLUDING FEE)	6-16-66
																REVISED FORECAST COST	
		2,985	8,527	16,151	25,248	34,748	51,351	61,955	75,897	90,262	105,522	118.6	131.6			ACTUAL COST (INCLUDING COMMITMENTS)	

LEGEND: PLANNED MILESTONES ▽ REVISED ▽² ETC. ▽² ETC.
COMPLETED MILESTONE ▼
PLANNED CUMULATED COST ■■■■■■ REVISED ■■■■■■
ACTUAL CUMULATED COST ———

2-1-62